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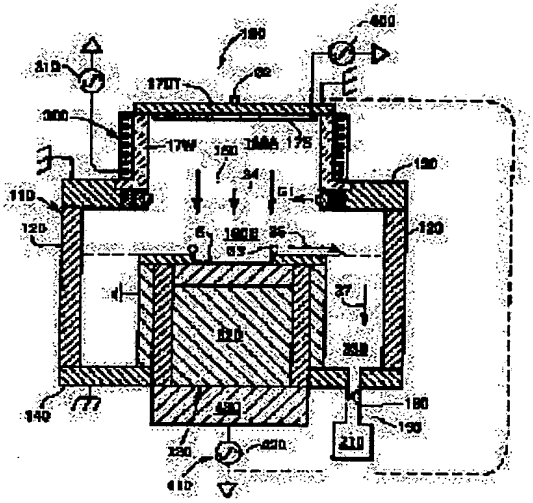
(54) IMPROVEMENT FOR SELECTIVITY IN ETCHING OXIDE ON NITRIDE

(57)Abstract:
PURPOSE: To stick a polymer containing a large number of carbons which does not dissociate under the presence of oxygen on a nitride and to etch an oxide on the nitride with high selectivity by adding a scavenger to fluorine to fluorine substitution hydrocarbon etching gas.



CONSTITUTION: A reactor system 100 is provided with a vacuum chamber housing 110, provided with a sidewall 120, an upper wall 130 and a bottom wall 140 and process gas is supplied to the chamber 110 by three manifold injection sources G1, G2 and G3, respectively positioned near the base part of a plasma source region 160A and a base body to be etched. When a silicon ion source or the scavenger to the fluorine such as graphite is brought into contact with plasma, SiF4 is generated, for instance, and the polymer stuck to a nitride layer contains less fluorine atoms and contains lot of the carbon as a result. The decomposition or reaction of the polymer, containing a large number of the carbon hardly occurs and almost infinite selectivity, is supplied to an oxide layer on the nitride layer.

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Industrial Application] This invention relates to the etching process for etching the oxide on a nitride. Furthermore, this invention relates to etching the silicon oxide on silicon nitride with high selectivity at a detail.
[Description of the Prior Art] The important technical problem in semi-conductor manufacture is to carry out etching removal of a nitride layer, for example, the silicon oxide layer on silicon nitride, or its part with the high selectivity over an oxide layer. Since both oxide ingredient and nitride ingredient are generally etched at the almost same rate in the etching plasma, they have to find out the approach of giving this selectivity. When using a fluorine permutation hydrocarbon as an etching agent, a fluorine reacts with the existing carbon and makes inactivation coating of a carbon-fluorine polymer generate on a base. However, this polymer is dissociated with the oxygen atom produced by etching of an oxide layer. Therefore, silicon oxide continues being etched and a nitride layer is etched at a very late rate for inactivation coating. However, since a passivation layer is attacked also with the isolation fluorine atom which exists in the plasma, a nitride also continues being etched. Therefore, the selectivity to which the etching ratio of silicon oxide pair silicon nitride becomes larger than about 8:1 is not acquired to current.
[0002]
[Problem(s) to be Solved by the Invention] In the case of the equipment of a submicron field, i.e., VLSI, and ULSI equipment, about 10:1 is exceeded, for example, since the selectivity of 30:1 or 40:1 is needed, it is very desirable to offer the etching process which etches the oxide on a nitride by the high selectivity exceeding 10:1.
[Means for Solving the Problem] We found out that the polymer containing many carbon which is not dissociated under existence of oxygen adhered on a nitride, when the scavenger to a fluorine was added to the fluorine permutation hydrocarbon etching gas for the oxide layer on a nitride. Consequently, the etch selectivity of infinity is almost obtained between oxide and a nitride.
[0003] Drawing 1 is the sectional view of the idiomatic etching chamber 10. Housing 12 is manufactured with aluminum and forms an etching chamber 14. A base 22 like a silicon wafer which should be processed is supported by electrode support 16. This base material 16 is usually cathode. The wall of housing 12 is usually an anode plate. Cathode 16 is connected to RF generator 18. The gas manifold 20 linked to the source of process gas (not shown) counters with the cathode base material 16, approaches and is ****(ed). By a series of orifices 23 of the gas manifold 20, process gas comes out of the gas manifold 20, and flows toward the direct base 22. If high-frequency power is supplied to the base base material 16 and process gas is supplied to a manifold 20, the plasma will occur to the space between a manifold 20 and a base 22. The exhaust air system 24 connected to the vacuum pump (not shown) maintains the pressure in a chamber, and exhausts waste gas and a resultant. Although the strict mechanism of this invention is unknown, it will believe, if the following logic explains the approach of this invention. When the fluorocarbon etching gas of CF4 which generally contains both carbon and a fluorine, C2F6, C3F8, and CH2F4 grade is exposed to the plasma, it is an isolation fluorine atom, and CF and CF2. The various fragmentation containing a radical etc. generates. The fluorine is useful

although the silicon oxide on a base is etched. However, the polymer of carbon and a fluorine is also generated in process of an etching process, and this adheres on a base and forms a passivation layer. This polymer contains about 30 % of the weight of carbon, and about 60 % of the weight of fluorines. Since such a polymer is attacked with an oxygen atom, the polymer which the oxygen atom from an oxide layer generates is dissociated, and etching of oxide is not barred. However, like [at the time of reaching the layer which does not contain oxygen, i.e., a nitride layer,], when oxygen does not exist, the oxygen which dissociates an inactivation polymer layer does not exist. Silicon oxide continues being etched at this time, and an inactivation nitride layer is etched at a later rate. However, an inactivation polymer is dissociated also with a fluorine, continuous generation of the fluorine ion in the inside of the plasma adds an impact to a polymer layer, or attack this, a polymer is made to dissociate, and, thereby, a nitride layer is similarly etched by the plasma. For this reason, the maximum selectivity of the oxide on the nitride attained by current was about 8:1.

[0004] However, when we decrease the fluorine content of an inactivation polymer and the amount of the isolation fluorine in the plasma was decreased, it found out that dissociation of an inactivation polymer decreased. If the scavenger to the silicon ion source or a fluorine like graphite is contacted to the plasma, an isolation silicon atom or a carbon atom will combine with a fluorine atom, for example, SiF4 will be generated, and, thereby, the number of the isolation fluorine ion in the plasma will decrease. Therefore, the polymer adhering to a nitride layer has more few fluorine atoms, namely, there are more many carbon atoms, and it "contains many carbon" as a result. A polymer is produced. In the purpose of this invention, the polymer containing many carbon is defined as a polymer containing the carbon exceeding less than about 40% of the weight of a fluorine, and about 50 % of the weight, and is inactive at a fluorine content plasma-etching agent. Therefore, if the polymer containing many carbon adheres to a nitride layer, the decomposition or the reaction containing many carbon of a polymer will hardly occur, but the selectivity of infinity will almost be given to the oxide layer on a nitride. It can give by some approaches, for example, the source of silicon is the silicon content gas and tetraethyl alt.silicate (henceforth TEOS) of a silane (SiH4), a permutation silane like diethylsilane (SiH2 (C2H4) 2), and SiF4 grade. It can add to the plasma. It decomposes, silicon content gas generates isolation silicon ion, and this catches an isolation fluorine atom. Therefore, carbon-fluorine polymer coating containing many carbon is formed on a nitride layer. Another method of making the carbon-fluorine polymer containing many carbon generate depends the source of silicon, i.e., a silicon mesh, on hanging to a plasma field. To the temperature which produces an isolation silicon atom in the reactor which catches a fluorine atom in that case, for example, the temperature of 150 degrees C or more, although the source of silicon, for example, a silicon wafer, can also be hung outside the plasma field in a reaction chamber, it must heat. In that case, a reaction chamber must be further equipped with a means to adjust the temperature of the source of silicon. the desirable method of making the carbon-fluorine polymer containing many carbon generate -- Collins etc. -- 1992 year 1 the coincidence for which it applied to the moon 24 day -- pending in court -- it is performing this approach in the new etching reactor indicated by application 07th / No. 824,856. The high frequency plasma-etching room including the source of isolation silicon is indicated by this application, and this can be other sources of supply of isolation silicon in contact with plasma like the third electrode made with silicon, or the silicon liner of an interior wall. The 3rd electrode can also be manufactured by the graphite as a source of supply of the carbon atom which can catch a fluorine.

[0005] The reactor system 100 contains the vacuum chamber housing 110 made from the anode plate-ized aluminum which has a side attachment wall 120, a upper wall 130, and a bottom wall 140, or other suitable ingredients about drawing 2 . A upper wall 130 has the central space 150 between source section of room plasma when divided in bottom room base processing section 160B and dome 170 which are divided between walls 120-120 160A. A dome 170 is formed as one layer like Xtal which was able to carry out the dielectric, or a reverse cup mold of a double wall. The exhaust air inside the chamber housing 110 (chamber 160) is controlled by the throttle valve 180 in vacuum Rhine 190 connected to the vacuum pump system 210 which is inserted in a bottom wall 140 and contains one or more vacuum pumps. Process gas can be supplied to a

chamber 110 by three sources of manifold impregnation, G1 and G2, and G3 which are located around the base of source field of plasma 160A, a dome 170, and the base etched respectively. All gas streams flow in accordance with the path 36 which goes to the outlet manifold 330 in accordance with the path 37 which goes to the vacuum system 210 from the outlet manifold 330 in accordance with the path 34 which faces to a base 5 from source field of chamber plasma 160A from a base 5. Radio-frequency energy is supplied to a dome 170 by the power source containing the antenna 300 of at least one the turn or coil which supplies power by high frequency supply and the matching network 310. An antenna 300 changes to resonance of an effective electromagnetic coupling by the source of the plasma. In a dome 170, it concentrates on the small volume divided into a coil antenna 300, and the plasma is generated. The active species containing ion, an electron, a free radical, and an excitation neutral moves toward the base 5 etched by the bulk flow based on the gas flow which reaches by diffusion and is generated by the gas manifold systems G1 and G2 and G3. Since the plasma sheath electrical potential difference of a base is increased alternatively and the ion energy of a base is increased alternatively, the bias energy input unit 410 including a power source 420 and the bias matching network 430 combines radio-frequency energy with the base support electrode 320. The chamber 110 has incorporated peculiar 3 pole arrangement which gives the new process control indicated by this specification. The base support electrode 320 is [the 3rd electrode of the chamber side attachment wall 120] dome upper wall plate 170T including an anode plate including cathode. Besides, it floated, was grounded, or connected with the RF electric power supply, and the wall electrode is preferably made of silicon, a silicon content alloy, or graphite. Moreover, it can be sacrifice silicon member 170S like a silicon wafer. This application is incorporated here as reference.

[0006] Although the etching process in a vacuum chamber is generally performed under an about 0.1-200mm torr pressure, generally an etching process is preferably performed by the about 5-50mm torr. In these comparatively high pressures, it is very desirable to approach and **** a gas manifold and the base etched, for example, to separate about 5cm (2 inches). This is because the electrical potential difference demanded decreases, one of the possible causes of damage to a base device is removed and the homogeneity of etching increases. In this invention, desirable etching agents are CF4, C2F6, and C3F8, and these generate only carbon ion and fluorine ion. Other known fluorides like CHF3 are "dirt". Since the hydrogen ion which causes a process is also generated, it is not so desirable. Generally the resultant of silicon and a fluorine can generate an volatile silicon-fluorine compound, and an exhaust air system can remove these from an etching chamber easily. However, when the source of silicon, for example, a silicon electrode, comes to be covered with a carbon-fluorine polymer as time amount passes, by heating an affected zone to an elevated temperature, or carrying out sputter etching of the polymer of an affected zone by the known approach, a polymer may be removed and a reactor may wash so that a polymer may be removed and isolation silicon may be again exposed to the plasma. Therefore, according to this invention, most very high selectivity between an oxygen content layer like silicon oxide and a non-oxygen content layer like silicon nitride can be acquired to infinity by adjusting the fluorine content of the plasma and decreasing the fluorine content of the adhering inactivation polymer. Although these polymers have susceptibility in oxygen and a fluorine, when oxygen does not exist (for example, when an etching agent reaches a nitride layer and the fluorine of the amount which decreased exists in the plasma), though decomposition of a polymer takes place, there is. [little] Although this invention is further explained in the following example, this invention is not limited to the detailed publication in this.

[0007] Example 1PECVD It is thickness about 5000-10,000 on the adhering silicon nitride layer. As the silicon wafer which has the silicon oxide layer of angstrom was mentioned above about drawing 2 in the chamber using the 3rd earth electrode which consists of silicon as a source of silicon, it etched in the high frequency etching chamber. Etching gas is C2F6 of a pressure the torr of about 2 - 30mm, a power source is 2000W, and bias voltage is 200. It is a bolt, and silicon disc 170S are attached in upper wall electrode 170T, and bias is carried out to them by the radio-frequency energy which are 2MHz and 1000W. The selectivity of the oxide on a nitride was 15:1.

[0008] It is LPCVD about an example 2 nitride layer. The approach of an example 1 was repeated except having made it adhere. The selectivity of the oxide on a nitride was 15:1. Selectivity can be adjusted by changing the power of a gas flow and a power source etc. by the approach learned by this contractor, so that the selectivity of the silicon oxide on silicon nitride may become the optimal about each base. By using the approach of this invention, the selectivity of infinity can almost be acquired. the operative condition of specification [this invention] -- although therefore indicated like, this invention is not limited to each source of silicon or each etching chamber. It is thought that other modes are understood by this contractor and they are also included by this invention. This invention is limited by only the claim.
[0009]

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DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] Drawing 1 is the sectional view of the etching system of common use.
[Drawing 2] Drawing 2 is the sectional view of a desirable etching system.

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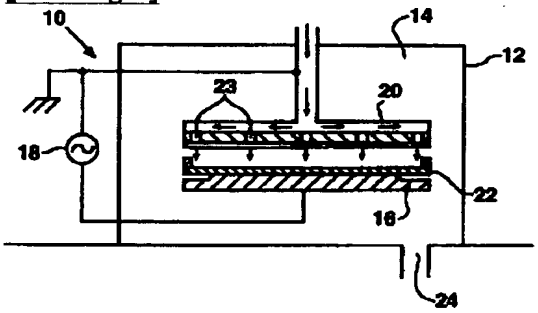
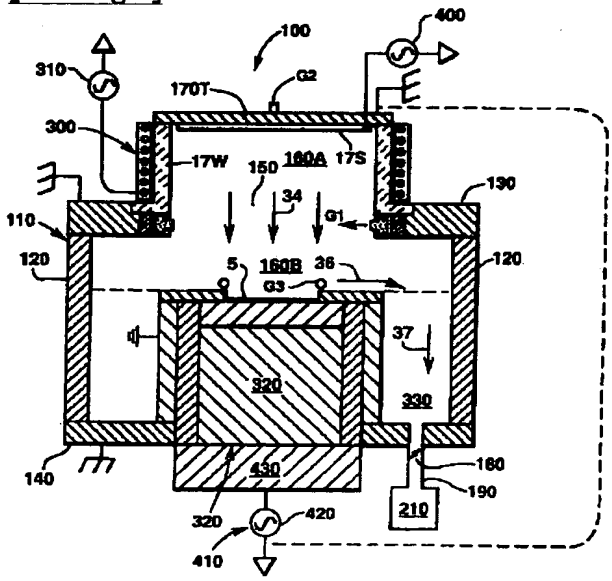
DRAWINGS

[Drawing 1]



[Drawing 2]



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